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Effect of different tea solutions on the color stability of composite resins

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ABSTRACT

Aims: The aim of this study is to evaluate the discoloration of supra-nanophile (Estelite Σ Quick) and nano-hybrid (Clearfil Majesty Esthetic) composites kept in three different brands of black tea (İstikan, Yellow Label and Çaykur) for three different periods (24 hours, 7 days and 28 days).

Methods: Specially produced Teflon molds with an inner diameter of 10 mm, an outer diameter of 12 mm, and a thickness of 2 mm were used. 28 pieces of Tokuyama Estelite Sigma Quick composite material and 28 pieces of Kuraray Clearfil Majesty Esthetic composite material were placed in the molds and polimerized. All samples were polished and initial color measurements were taken. The samples were divided into three experimental groups (Istikan, Lipton yellow label, Çaykur tiryaki) and a control group (distilled water) (n=7). The samples were kept in this solution for 1 day, 7 days and 28 days, and at the end of the period, color measurements were measured with a spectrophotometer. Data were recorded according to the CIE Lab system. One-way analysis of variance (ANOVA) and Tukey test were applied to determine the data, and the Kruskal Wallis H test was used to make comparisons based on variables with more than two categories in the data.

Results: In this research, it was detected that there was a statistically significant difference between the 24-hour and 7th-day coloration results of Tokuyama brand according to the beverages ($p<0.05$). According to the beverages, it was found that there was a statistically significant difference between the 28-day coloration results of Tokuyama and Kuraray brands.

Conclusion: In the supra-nanofilled and nanohybrid filler composite resins we used in our study; it was observed that the coloration increased as the residence time in the solution increased.

Keywords: Composite resins, tea, discoloration, spectrophotometer

INTRODUCTION

In recent years, the use of dental composite resins as restorative materials in both anterior and posterior group teeth has become quite widespread due to their ability to restore tooth function, preserve the natural tooth appearance, bond to the tooth through adhesion, and are also conservative.[1] Today, with nanotechnology, the aesthetic and physical properties of dental composite resins continue to be improved in order to increase their clinical performance. It is desired that composite resins can maintain these improved properties as long as they remain in the oral environment.[2,3]

One of the biggest challenges in clinical practice is ensuring the aesthetics of restorative materials, particularly in the anterior region. One of the most important factors that may cause the restoration to be replaced and lead to extra time and financial loss is the inability of aesthetically restorative materials to maintain color stability.[4] Various factors such as temperature changes in the oral environment, individuals' drinking habits and oral hygiene influence the coloration of dental composite resins in the oral cavity.[5] In studies, it has been reported that composite resins are frequently affected by beverages containing coloring pigments such as tea, coffee, cola, and fruit juices.[6,7] In addition, the concentration and size of the filler particles of the dental composite and the organic matrix formulation are among the factors affecting the coloration of restorative materials.[8]

The coloration of composite resins can be measured with various devices, such as a spectrophotometer and a colorimeter.[9] The spectrophotometer measures tooth color using the CIE Lab color system. The L* coordinate points brightness, the a* coordinate indicates the red or green component, and the b* coordinate represents yellowness or blueness. The intersection of these three coordinates gives the value of that color. Color change is expressed by a value called ΔE.[10]

It is seen that black tea consumption habits are higher in our country compared to other beverages. In addition to the consumption of black tea grown in Turkey, Ceylon tea consumption is also quite high.

The aim of the study is to evaluate the discoloration of supra-nanophile (Estelite Σ Quick) and nano-hybrid (Clearfil Majesty Esthetic) composites kept in three different brands of black tea (İstikan, Yellow Label and Çaykur) for three different periods (24 hours, 7 days and 28 days).

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METHODS

Ethics committee approval is not required because of designed of the study. All procedures were carried out in accordance with the ethical rules and principles. Tokuyama Estelite Sigma Quick (A2) and Kuraray Clearfil Majesty Esthetic (A2) were used to check the color change in our study. Black Ceylon tea (Istikan), black tea (Lipton yellow label tea bag), and black tea (Çaykur tiryaki tea bag) were used as three different coloring solutions, and distilled water was used as the control group.

Sample Preparation

In our study; specially produced Teflon molds with an inner diameter of 10 mm, an outer diameter of 12 mm and a thickness of 2 mm were used to prepare the samples. 28 pieces of Tokuyama Estelite Sigma Quick composite material and 28 pieces of Kuraray Clearfil Majesty Esthetic composite material were placed in the molds, smoothed with the help of a mouth spatula, and overflow of excess material was ensured by first applying transparent tape and then glass coverslip. The overflowing material was removed from the molds. Each sample was then polymerized from both surfaces with an LED-B light device (Woodpecker Led-G / China) according to the manufacturer's instructions. To ensure surface standardization, Sof-Lex (3M ESPE, St. Paul, MN, USA) polishing discs were applied to all specimens by a single operator at 20,000 rpm.

Since there were four different experimental solutions, including three different brands of tea solutions and one distilled water, the samples from each composite group were divided into 4 groups, and a total of 8 groups were obtained, with 7 samples in each group.

Solution Preparation

For the preparation of tea solutions, 200 ml of 100°C boiling water was used for each tea bag. All solutions were prepared according to the manufacturer's instructions. During the preparation of the tea solution, the tea bags were gently shaken at 0, 2, and 5 minutes and removed from the water at 5 minutes.

Color Measurement

Samples prepared for color measurement were kept in an incubator at 37°C for 24 hours. The specimens were washed with distilled water before each measurement and then dried completely with blotting paper. The first color measurements were then performed with a Vita Easyshade spectrophotometer (VITA Easyshade V, Vita Zahnfabrik, Bad Sackingen, Germany). Each color measurement was performed under standard conditions in a dark room under fluorescent daylight lamp (Master TL-D 90 Graphica 18W965SLV/10, Philips, The Netherlands) illumination and on a gray background. For each sample, measurements were repeated three times, and L, a, and b values were recorded. The spectrophotometer was calibrated before each measurement. After the first measurements, all samples were divided into groups, 8 in each group, and placed in experimental solutions. The solutions were divided into 5 ml per group to cover each sample completely. All samples in the solutions were kept in an incubator at 37°C between measurements. The solutions were changed regularly, once a week. On days 1, 7, and 28, color measurements were repeated.

Statistical Analysis

The data obtained in the study were analyzed using the SPSS (Statistical Package for Social Sciences) for Windows 25.0 program. Descriptive statistical methods (mean, standard deviation) were used when evaluating the data. Compliance with the normal distribution was checked with normality tests and kurtosis and skewness values. The normal distribution of the data used depends on the skewness and kurtosis values being between ±3.[11]

In normally distributed data, independent sample t-test was applied for comparisons based on variables with two categories, one-way analysis of variance (ANOVA) was applied for comparisons based on variables with more than two categories, and Tukey test was applied to evaluate which groups caused the difference. In data that did not show normal distribution, the Kruskal Wallis H test was applied for comparisons based on variables with more than two categories. The significance level was accepted as 95%.

RESULTS

When 24-hour coloration results were examined, it was observed that there was no statistically significant difference between the results of distilled water, Lipton, and Çaykur according to the brand (p>0.05).

It was found that there was a statistically significant difference between the 24-hour Ceylon tea coloration results according to the brand (p<0.05). In Ceylon tea results, it is seen that Tokuyama brand 24-hour coloration values are higher than Kuraray brand values.

It was detected that there was no statistically significant difference between Kuraray brand 24-hour coloration results according to beverages (p>0.05).

It was observed that there was a statistically significant difference between Tokuyama brand 24-hour coloration results according to beverages (p<0.05). It is seen that Ceylon tea coloration values are higher than distilled water and Çaykur coloration values; Lipton coloration values are higher than distilled water and Çaykur coloration values. **(Table 1)**

Table 1. 24 hours

	24 hours				
	Distilled Water	**Ceylon Tea**	**Lipton**	**Çaykur**	**p**
Kuraray	1.77±0.79	1.74±0.59	3.55±2.25	2.94±1.24	0.059
Tokuyama	1.83±1.28	3.44±1.64	3.46±1.44	1. 88±0.99	**0.041***
p	0.923	**0.034***	0.932	0.104	

When 7-day coloration results were researched, it was observed that there was no statistically significant difference between the results of distilled water, Ceylon tea, Lipton, and Çaykur according to the brand (p>0.05).

It was observed that there was no statistically significant difference between Kuraray brand 7-day coloration results according to beverages (p>0.05).

It was seen that there was a statistically significant difference between Tokuyama brand 7-day coloration results according to beverages (p<0.05). Lipton coloration values were higher than distilled water coloration values. **(Table 2)**

Table 2. 7 days

	7 days				
	Distilled Water	Ceylon Tea	Lipton	Çaykur	p
Kuraray	2.76±0.87	5.12±1.59	4.86±2.12	4.77±2.14	0.069
Tokuyama	2.48±1.75	4.90±2.38	5.42±1.59	3.25±1.15	**0.016***
p	0.713	0.843	0.587	0.125	

When 28-day coloration results were researched, it was determined that there was no statistically significant difference between the results of distilled water, Ceylon tea, Lipton, and Çaykur according to the brand ($p>0.05$).

It was found that there was a statistically significant difference between Kuraray brand 28-day coloration results according to beverages ($p<0.05$). It is seen that Ceylon tea coloration values are higher than distilled water, Lipton, and Çaykur coloration values; Lipton coloration values are higher than distilled water and Çaykur tea coloration values.

It was seen that there was a statistically significant difference between Tokuyama brand 28-day coloration results according to beverages ($p<0.05$). It is seen that Ceylon tea and Lipton coloration values are higher than distilled water coloration values. **(Table 3)**

Table 3. 28 days

	28 days				
	Distilled Water	Ceylon Tea	Lipton	Çaykur	p
Kuraray	2.99±0.86	8.99±2.22	6.12±1.51	5.36±2.02	**0.000***
Tokuyama	3.29±1.78	7.04±2.80	6.64±1.76	4.61±1.16	**0.005***
p	0.690	0.174	0.560	0.415	

DISCUSSION

Color plays an important role in achieving optimum aesthetics. One of the biggest disadvantages of resin composites is the discoloration of the restoration.[12] Color change of composite resins may be the result of various internal or external factors. The degree of discoloration can vary depending on various intrinsic factors such as resin material composition (filler particles, organic matrix, activators and photoinitiators), hydrophilic-hydrophobic structure of monomers, water absorption and degree of polymerization.[13,14] For this reason, two restorative materials with different monomer structures and filler particle sizes were used in our study. In addition, external factors that contribute to discoloration include eating habits, smoking and inadequate oral hygiene.[15]

In restoration finishing processes, it has been stated that the coloration properties of dental composite resins are influenced by the application of different finishing and polishing methods.[16] In many studies, aluminum oxide discs have been reported to be effective materials for creating smooth surfaces.[17,18] In our study, Sof-Lex (3M ESPE, St. Paul, MN, USA) polishing discs were applied to all specimens by a single researcher at 20,000 rpm in the polishing procedure following the finishing process applied with diamond finishing burs to ensure standardization.

Composite resins are constantly exposed to saliva, food, and beverages in the mouth. A wide variety of test solutions or beverages, such as tea, coffee, red wine, cola, acidic drinks and artificial saliva, have been used in the literature to evaluate the discolorations of dental restorative materials.[19-21] Since black tea consumption habits are higher in Turkey compared to other beverages, two different brands of black tea grown in Turkey and Ceylon black tea were used as coloring solutions.

Visual or color measurement devices can be used to evaluate color stability.[22] Anusavice et al.[23] stated that instrumental colorimetric measurements can eliminate subjective errors. For this reason, colorimetry and spectrophotometry techniques have been used dependable in various dental studies.[1] In our study, a spectrophotometer device (Vita Easyshade) that allows quantitative color assessment and the CIE L*a*b* system was used to measure color change to avoid error due to subjective evaluation.

Some researchers have pointed out that the retention time of restorative materials in beverages may affect the level of coloration.[13,24] Based on the study of Ertaş et al.[25], who mentioned that 24 hours of soaking time in beverages corresponds to one month in vivo, 24 hours, 7 days, and 28 days of soaking time were preferred in this study.

In our study, when the 24-hour coloration results were researched, it was found that there was no statistically significant difference between the results of distilled water, Lipton yellow label black tea, and Çaykur black tea according to the beverage brand ($p>0.05$), but when the beverages were compared among themselves, it was seen that there was a statistically significant difference between Ceylon black tea and other brands of teas and distilled water ($p<0.05$). We think that the statistically significant difference may be due to the color pigment in the structure of Ceylon tea.

When compared by beverage, there was a statistically significant difference ($p<0.05$) in Estelite Σ Quick (Tokuyama Dental Co., Tokyo, Japan) compared to Clearfil Majesty Esthetic (Kuraray Medical Co., Tokyo, Japan) at 24 hours and 7 days. Clearfil Majesty Esthetic is a nano-hybrid composite resin whose organic matrix consists of Bis-GMA, hydrophilic aliphatic dimethacrylate. Estelite Σ Quick is a supra-nanofilled composite resin with an organic matrix consisting of Bis-GMA and TEGDMA. Studies have shown that while water absorption is 0-1% in Bis-GMA-based resins, this rate can increase up to 3-6% depending on the rate of TEGDMA added.[26] In a study, it was reported that TEGDMA was the monomer structure that caused more water absorption than Bis-GMA, Bis-EMA, and UDMA.[27] In our study, similar to this study, Estelite Σ Quick, whose organic matrix consists of Bis-GMA and TEGDMA, showed statistically more coloration in tea solutions at 24 hours and 7 days compared to Clearfil Majesty Esthetic. However, there was a statistically significant difference between the 28th-day coloration results of both composite resins according to the solutions ($p<0.05$). It was observed that coloration increased in both materials as the exposure time to the solution increased.

According to the 28th day coloration result, it is seen that the coloration values of Ceylon black tea and Lipton yellow label in Estelite Σ Quick are higher than distilled water coloration values. In Clearfil Majesty Esthetic, Ceylon black tea coloration values were higher than distilled water, Lipton yellow label and Çaykur black tea coloration values; Lipton yellow label coloration values were higher than distilled water and Çaykur black tea coloration values.

Filler properties also have important effects on the coloration of composite materials. Inorganic fillers on the surface can break away from the structure of the resin matrix during the clinical life of the material and cause a cavity to form in that area. Since the filler particle sizes of nano-filler composite resins are very small, it is thought that they show

a lower degree of surface discoloration than other materials when they are detached from the surface. In some studies, it has been reported that increasing the filler ratio in this type of composite material causes less coloration due to the decrease in the organic matrix ratio.[28-31] One of the composite materials used in our study was supra- nanofilled (Estelite Σ Quick), and the other was nano-hybrid (Clearfil Majesty Esthetic), and their filler ratios were close to each other by weight. Although Estelite Σ Quick had a smaller filler particle size and a higher filler ratio, the tea solutions showed statistically more coloration than Clearfil Majesty Esthetic at 24 hours and 7 days. We think that not only the filler ratio and particle size but also the organic matrix of the material may have an effect on the degree of coloration.

Limitations of This In Vitro Study

In the oral cavity, teeth are not exposed to a drink for 24 hours, and saliva has a washing effect, but in our study, the specimens were exposed to solutions during the study period. Additionally, factors such as wear or thermal changes were not simulated in our study.

CONCLUSION

In the supra-nanofilled and nanohybrid filler composite resins we used in our study; it was observed that the coloration increased as the residence time in the solution increased. We suggest that these composite materials, which have been developed in recent years with the aim of making aesthetic restorations, should be investigated with composite resins containing different organic matrix and inorganic fillers and different solutions by simulating the oral environment.

ETHICAL DECLARATIONS

Ethics Committee Approval: Ethics committee approval is not required as the study. All procedures were carried out in accordance with the ethical rules and the principles.

Informed Consent: Because of designed of the study, informed consent is not required.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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REFERENCES

1. Ardu S, Braut V, Gutemberg D, Krejci I, Dietschi D, Feilzer AJ. A long-term laboratory test on staining susceptibility of esthetic composite resin materials. *Quintessence Int.* 2010;41(8):695-702.
2. Öztürk E, Hickel R, Bolay S, Ilie N. Micromechanical properties of veneer luting resins after curing through ceramics. *Clin Oral Investig.* 2012;16(1):139-146.
3. Fontes ST, Fernández MR, de Moura CM, Meireles SS. Color stability of a nanofill composite: effect of different immersion media. *J Appl Oral Sci.* 2009;17(5):388-391.
4. Festuccia MS, Garcia Lda F, Cruvinel DR, Pires-De-Souza Fde C. Colour stability, surface roughness and microhardness of composites submitted to mouth rinsing action. *J Appl Oral Sci.* 2012;20(2):200-205.
5. Falkensammer F, Arnetzl GV, Wildburger A, Freudenthaler J. Color stability of different composite resin materials. *J Prosthet Dent.* 2013;109(6):378-383.
6. Erdemir U, Yildiz E, Eren MM. Effects of sports drinks on color stability of nanofilled and microhybrid composites after long-term immersion. *J Dent.* 2012;40(Suppl 2):e55-e63.
7. Moon JD, Seon EM, Son SA, Jung KH, Kwon YH, Park JK. Effect of immersion into solutions at various pH on the color stability of composite resins with different shades. *Restor Dent Endod.* 2015;40(4):270-276.
8. Yap AU, Wee KE. Effects of cyclic temperature changes on water sorption and solubility of composite restoratives. *Oper Dent.* 2002;27(2):147-153.
9. Berns RS, Bilmeyer FW, Saltzman M. Principle of color technology. 3rd ed. New York, Wiley, 2000, pp. 71-74.
10. Gómez-Polo C, Gómez-Polo M, Celemin-Viñuela A, Martínez Vázquez De Parga JA. Differences between the human eye and the spectrophotometer in the shade matching of tooth colour. *J Dent.* 2014;42(6):742-745.
11. Shao AT. Marketing research: An aid to decision making, Cincinnati, Ohio: South-Western/Thomson Learning. 2012.
12. Dozic A, Kleverlaan CJ, El-Zohairy A, Feilzer AJ, Khashayar G. Performance of five commercially available tooth color-measuring devices. *J Prosthodont.* 2007;16(2):93-100.
13. Backes CN, FranÇa FMG, Turssi Cp, Amaral FLBD, Basting RT. Color stability of a bulk-fill composite resin light-cured at different distances. *Braz Oral Res.* 2020;34:e119.
14. Aydın N, Karaoğlanoğlu S, Oktay EA, Kılıçarslan MA. Investigating the color changes on resin-based CAD/CAM Blocks. *J Esthet Restor Dent.* 2020;32(2):251-256.
15. Quek SHQ, Yap AUJ, Rosa V, Tan KBC, Teoh KH. Effect of staining beverages on color and translucency of CAD/CAM composites. *J Esthet Restor Dent.* 2018;30(2):E9-E17.
16. Heintze SD, ForjanicM, Rousson V.Surface roughness and gloss of dental materials as a function of force and polishing time in vitro. *Dent Mater.* 2006;22:146-165.
17. Lu H, Roeder LB, Powers JM.Effect of polishing systems on the surface roughness of microhybrid composites. *J Esthet Restor Dent.* 2003;15(5):297-303.
18. Venturini D, Cenci MS, Demarco FF, Camacho GB, Powers JM. Effect of polishing techniques and time on surface roughness, hardness and microleakage of resin composite restorations. *Oper Dent.* 2006;31(1):11-17.
19. Catelan A, Briso ALF, Sundfeld RH, Goiato MC, Dos Santos PH. Color stability of sealed composite resin restorative materials after ultraviolet artificial aging and immersion in staining solutions. *J Prosthet Dent.* 2011;105(4):236-241. doi:10.1016/S0022-3913(11) 60038-3
20. Khosravi M, Esmaeili B, Nikzad F, Khafri S. Color stability of nanofilled and microhybrid resin-based composites following exposure to chlorhexidine mouthrinses: an in vitro study. *J Dent.* 2016;13(2):116-125.
21. Soares-Geraldo D, Scaramucci T, Steagall-Jr W, Braga SRM, Sobral MAP. Interaction between staining and degradation of a composite resin in contact with colored foods. *Braz Oral Res.* 2011;25(4):369- 375.
22. Patil A, Muliya VS, Pentapati KC, Kamath S. Effect of Green, Tulsi, and Areca teas on the color stability of two composite resin materials - an in vitro spectrophotometric analysis. *Clin Cosmet Investig Dent.* 2020;12:423-428.
23. Anusavice, KJ. Phillips' science of dental materials. 11th ed. St. Louis: Elsevier. 2003. p. 46-51.
24. Llena C, Fernández S, Forner L. Color stability of nanohybrid resin-based composites, ormocers and compomers. *Clin Oral Investig.* 2017;21(4):1071-1077.
25. Ertaş E, Güler AU, Yücel AC, Köprülü H, Güler E. Color stability of resin composites after immersion in different drinks. *Dent Mater J.* 2006;25(2):371-376.
26. Barutcigil C, Yildiz M. Intrinsic and extrinsic discoloration of dimethacrylate and silorane based composites. *J Dent.* 2012;40:57-63.
27. Sideridou I, Tserki V. Study of water sorption, solubility and modulus of elasticity of light cured dimethacrylate-based dental resins. *Biomaterials.* 2003;24(4):655-665.
28. Villalta P, Lu H, Okte Z, Garcia-Godoy F, Powers JM. Effects of staining and bleaching on color change of dental composite resins. *J Prosthet Dent.* 2006;95(2):137-142.
29. Paravina RD, Roeder L, Lu H, Vogel K, Powers JM. Effect of finishing and polishing procedures on surface roughness, gloss and color of resin-based composites. *Am J Dent.* 2004;17(4):262-266.
30. Özata, MY, Bakır EP, Ünal S, et al. Effect of different tea brands on color change of flowable resin composite. *Anatolian Curr Med J.* 2023;5(4):454-458.
31. Akleyin, Ebru, Bakır EP, Ünal S, Polat G, Özata, MY. Effect of single serve sachet powder drinks on color stability of a nano-hybrid composite resin. *J Health Sci Med.* 2023; 6(1):13-17.